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Apollo Project Memo No. 1933

TO: Distribution

FROM: George W. Cherry

DATE: June 27, 1968

SUBJECT: LM Program Items Discussed and Acted on at the 19th SCB Meeting

General Comments

Fred Martin and I represented MIT at the 19th SCB meeting. There were so many items presented at this SCB that Fred will discuss the CSM program items in another memo.

There were some COLOSSUS PCR's which have applicability to LUMINARY, also. A good example is PCR 468 which requests that R32, the target Delta V routine, be changed into a program, P76, so that the permanent state vector update can be properly restart protected. This wasn't necessary on SUNDANCE, a strictly earth-orbital program; but it is very important on lunar programs. This MIT-orginated PCR on COLOSSUS deliberately chose 76 for the Target Delta V program number so that the LM could have the same change. However, we didn't forward the LUMINARY PCR at the same time. Thus, the board, who approved the PCR for COLOSSUS, expect a similar one for LUMINARY. Fred and I have resolved that we will coordinate the submission of PCR's from now on so that the board gets a pair of PCR's in each case where there is applicability to both programs.

NASA/MSC did the same thing Fred and I did, incidentally. NASA submitted two PCR's, PCR 212 and PCR 213, which were written for COLOSSUS only (see Fred's memo for more about them); but they obviously should apply to LUMINARY also. Now if Fred and George will get together and Gunter Sabionski and Tom Price will get together . . .

There was another PCR submitted to the board for COLOSSUS which was also applicable to LUMINARY. This is PCR 439.1. See Fred's memo for details.

Action Items

H. Byington presented the APS data that is available for the Rocketdyne injector minimum impulse engine characteristics. It is shown in Figure 1. We were directed to put this new minimum impulse data into LUMINARY and SUNDANCE. See my handwritten Appendix A for the program numbers implied by the graph of impulse versus engine command on time. There was a discussion about the minimum time we could fire the APS without subsequent freeze-up. Byington stated that a 0.22 second burn could cause freeze-up. Hell, you don't get much of an impulse for that short a firing anyway. The crew can avoid a short firing in P42 (choosing P41 instead) when V_g is that small. P71 is another matter. Our PCR on P71 had a delay in it before we turn off the engine and if Byington can tell us the delay we can avoid difficulty there also. If P71 is chosen by V37E 71E rather abort stage - - Presto! - we have a work-around in P71 anyway. But if the crew want to leave the DPS in a hurry - - imminent DPS blow-up - - the delay in P71 following an Abort Stage will a) give a separation impulse and b) prevent freeze-up. Bill Tindall has an action item to say how to avoid short P71 burns. I believe we just answered it.

Action: Program change action to Dan Lickly. Dan, with Peter Adler gone who can put in the new data? Rana Batra, maybe? GSOP change to Peter Philliou. Checking my Appendix A to Peter Philliou or Bahraj Sokkappa.

LUMINARY PCR's

The total impact from approved LUMINARY PCR's is 8 days.

PCR 207.2 — Section II GSOP changes.

Disposition: Approved for Zero slip.

Action: Bob Tinkham/Frank Williams will implement the GSOP changes. The result will be a Rev. 1 of Section II, predicted for publication on 24 July 1968.

PCR 210 Increase DPS Throttle Recovery Limit.

Disposition: Approved for Zero Slip.

Action: Craig Schulenberg/Don Eyles will implement the program change.

GSOP Action: Bernie Kriegsman.

Implementation: The agreed-upon implementation is to place both the throttle recovery limit and the pulse out level into erasables which will be pad-loaded. These are single-precision erasables which Craig told me can come from the W-matrix storage area. For simulations, we should start using 57% for throttle recovery, and the present value for the pulse-out level.

Comment: This change saves 9 fps during landing.

PCR 214 DSKY Light Utilization for LR.

Disposition: Approved for LUMINARY with a 4 day schedule impact.

Action: Jim Nevins/Russ Larson to determine which two lights should be used. Bob Covelli to implement the new scheme. Keith Glick to provide needed digital simulation changes. Ed Copps to appoint someone to produce Section 4 GSOP change pages. Bernie Kriegsman or Bob White to provide any Section 5 GSOP change pages.

Implementation:

1. The DSKY Alt. Light will be on steady if no Alt. Data Good is present.
2. The DSKY Vel. Light will be on steady if no Vel. Data Good is present.
3. The DSKY Alt. Light will flash if the Alt. Reasonability Test is failed.
4. The DSKY Vel. Light will flash if the Vel. Reasonability Test is failed.
5. The Program Alarm will come on if the antenna position is not correct.
6. The DSKY Alt. Light will be on steady if there is no low scale discrete.

PCR 400 Provide RR Downlink Data on Lunar Surface.

Disposition: Approved for 2 days on LUMINARY. This 2 days has already been counted in the development plan.

PCR 400 (Continued)

Action: Bob White for Section 5 change pages. Peter Volante or Virginia Dunbar for program modifications.

Implementation: The data rate in P22 should be as high as possible whether the mode is no update (V95E) or not. Thus, the two 15 second delays should be removed. The deletion of the delay in the update mode was coordinated by me with Bob White and with NASA (Tom Gibson).

PCR 420.2 Rearrangement of Extended Verbs:

Disposition: Approved for Zero Slip

Action: Craig Schulenberg to provide program modifications. Ed Copps to appoint someone for Section 4 change pages.

Implementation:

V67 (not V45) should select W Matrix RMS error display
V61 should select Mode 1 attitude error display
V62 should select Mode 2 attitude error display
V60 (not V61) Command LR to Position 2
V63 (not V62) Sample Radar once per second (R04)

Comments: The objective was to make LUMINARY like COLOSSUS when adding Mode II attitude error display.

PCR 205 DSKY Display of Raw Radar Data

Disposition: Held over.

Action: M. Contella and T. Price of MSC to confer with me on a new PCR to accomplish the objectives desired.

The following PCR's were all submitted by MIT and approved by the SCB. Because these PCR's originated at MIT and were the subject of many discussions before they were submitted, I will not dwell upon them very much. The implementation is usually obvious from the PCR itself. In the case of PCR 472, I have provided a flow graph.

I withdrew PCR 479 before the Board convened. On Monday morning I conferred with Floyd Bennett, Tom Price, Neil Armstrong and Buzz Aldrin and we come to the following proposal for using the LR above 25,000 feet. By a previous PCR, PCR 137, the landing radar routine will be turned on at 35,000 feet. However, we will continue, as at present, to inhibit X-axis over-ride at 30,000 feet. If the crew is still ogling the lunar surface at 35,000 feet of course the LR won't lock on and our altitude data good (bad?) light will illuminate. When the astronaut sees the light come on he knows that R12 is running. If he wants to he can then go windows up, LR down and the light should go out. At 30,000 feet we inhibit X-axis over-ride and point the windows up, the radar down.

<u>PCR 470</u> <u>P68 Addition.</u>

<u>Disposition</u>: Approved with a two day schedule impact on LUMINARY.

<u>Action</u>: Mr. Eyles to modify the program. Mr. Forbes Little to prepare the GSOP change pages.

<u>Implementation</u>: Obvious from PCR.

<u>PCR 472</u> <u>Simplification of P71.</u>

Disposition: Approved with Zero Slip.

<u>Action</u>: Mr. Berman to implement in program. Mr. Little to provide GSOP change pages.

Implementation: See Flow graph in Figure 2.

PCR 475 Extension of R10 Capability.

Disposition: Approved by board after Mr. Kraft left. Therefore, it needs his signature. If he signs it, it extends LUMINARY one more day.

Action: Wait for Mr. Kraft's signature.

PCR 478 Ascent Guidance Equation Compensation.

Disposition: Approved for one day extension on LUMINARY.

Action: Larry Berman who conceived the PCR now has the pleasure of implementing it. Bill Marscher, who has the pleasure of preparing the change pages? Larry, please write down the equations you are using.

Comments: Floyd Bennett and Dan Payne helped me present this. They were very co-operative.

Distribution

R. Ragan	F. Martin	G. Sabionski FS5
L. Larson	P. Philliou	T. Price FS5
D. Hoag	B. Sokkappa	H. Byington PD6
R. Millard	R. Batra	W. Tindall FM
K. Greene	P. Adler	T. Gibson FM2
R. Battin	R. Tinkham	T. Stokes FS5
N. Sears	F. Williams	M. Contella CF24
A. Kosmala	C. Schulenberg	F. Bennett FM6
W. Marscher	D. Eyles	N. Armstrong CB
J. Nevins	B. Kriegsman	E. Aldrin CB
E. Copps	R. Covelli	D. Payne FM6
D. Lickly	K. Glick	
W. Widnall	R. White	
S. Copps	P. Volante	
R. Werner	V. Dunbar	
L. Berman	F. Little	
J. Saponaro		

Appendix A. Interpretation of Minimum Impulse Da

From the graph in figure 1, we can determine the three constants needed for the program, K_1, K_2, K_3.

K_1 is obvious from the figure since K_1 is the impulse from a one second burn.

K_2 and K_3 are derived on the next page. By the way, K_2 in the SUNDANCE GSOP (page 5.8-2) has the strange value of -24.9 Kg-m/cs. I don't understan the negative sign.

The values I get are

$$\boxed{\begin{aligned} K_1 &= 2800 \text{ lb-sec} \\ K_2 &= 700 \text{ lb-sec} \\ K_3 &= 3500 \text{ lb-sec/sec} \end{aligned}}$$

D.W.C.

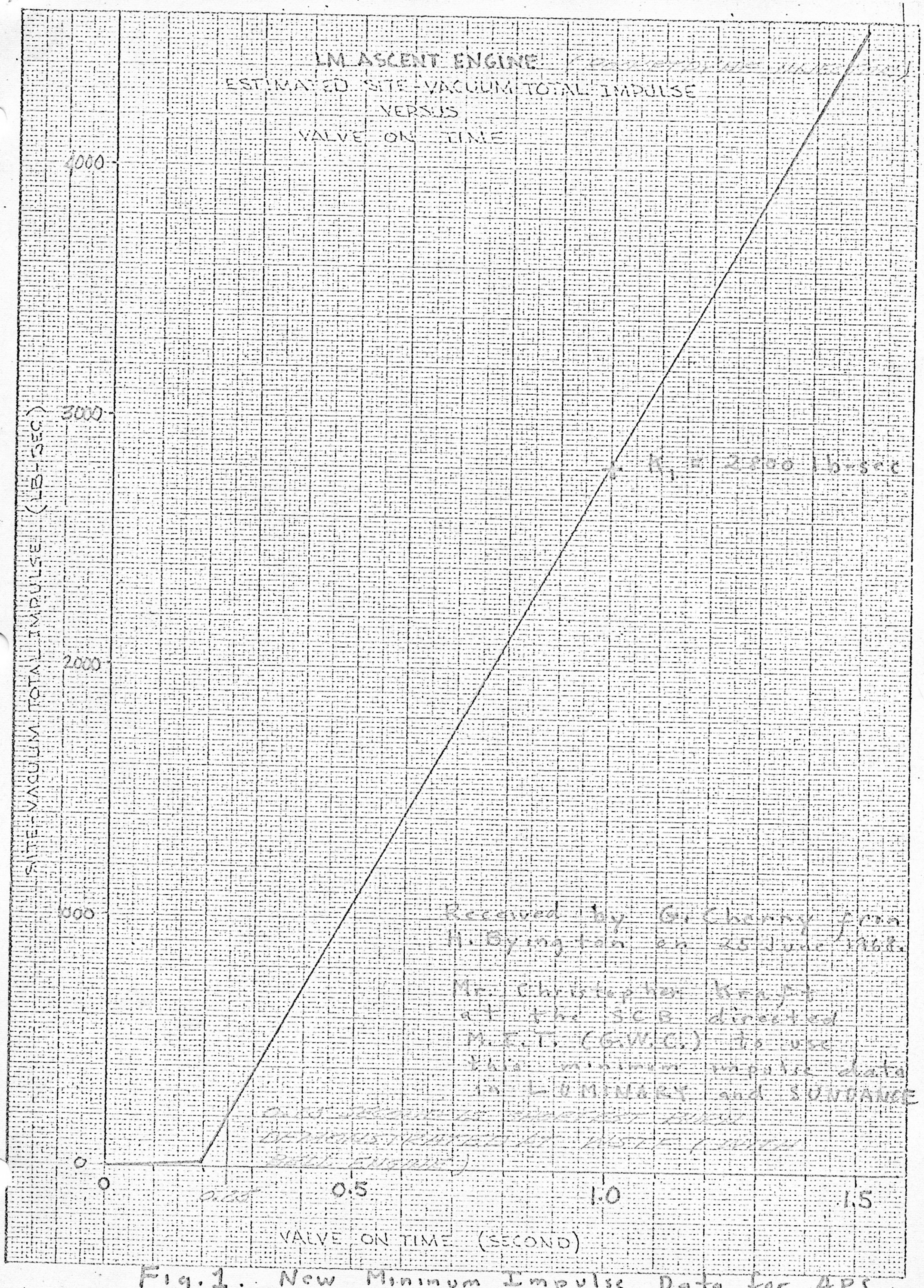
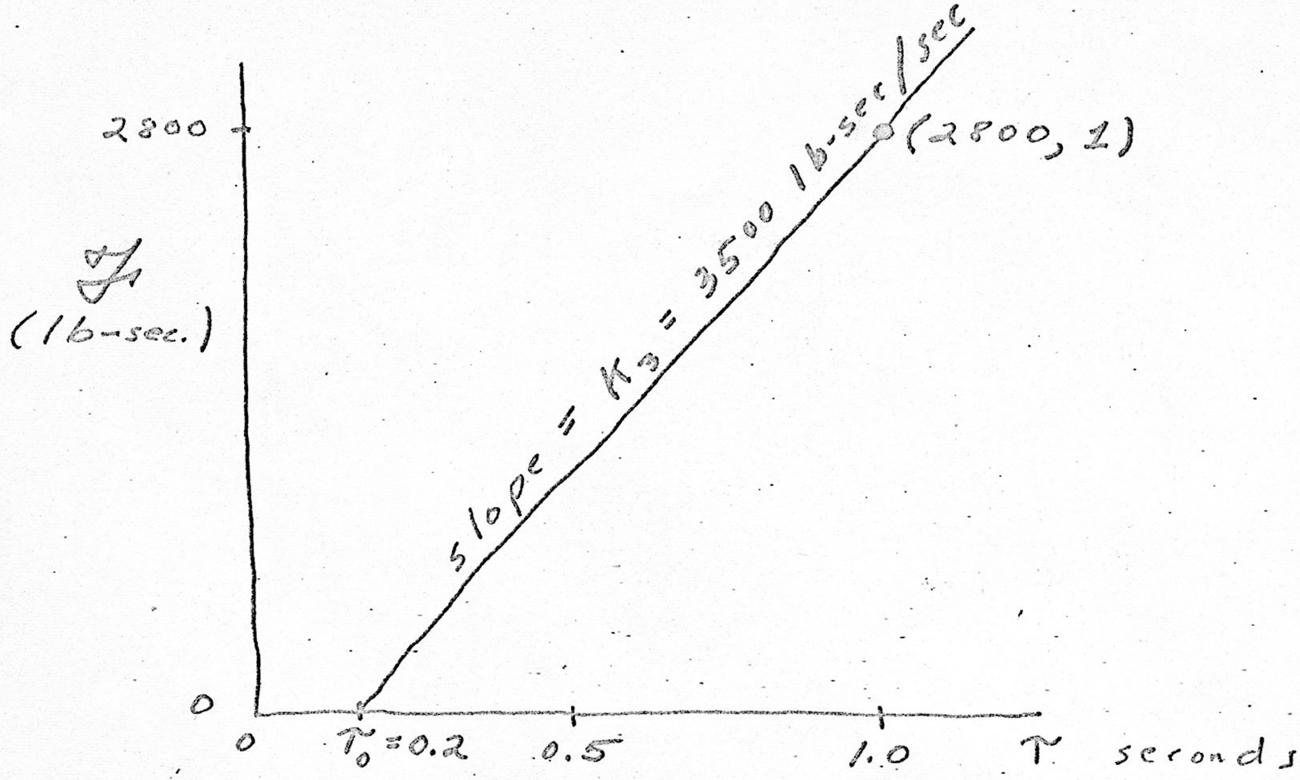


Fig. 1. New Minimum Impulse Data for APS

Appendix A (cont.)

Interpretation of New Minimum Impulse Data



Equation of minimum impulse line is:

$$\mathcal{I} = K_3(\tau - \tau_0) = K_3\tau - K_3\tau_0 \qquad (1)$$

$$\mathcal{I} = K_3\tau - K_2 \quad \text{where } K_2 = K_3\tau_0 \qquad (2)$$

Dividing each side of Eq. (2) by the mass of the S/C yields the V_g due to an impulsive burn

$$\frac{\mathcal{I}}{m} = V_g = \frac{K_3}{m}\tau - \frac{K_2}{m} \qquad (3)$$

Solving Eq. (3) for τ yields

$$\tau = T_{go} = (V_g m + K_2)/K_3 \qquad (4)$$

Eq. (4) is the same as in R577, p. 5.3-30

$K_2 = K_3 T_0 = 3500(0.2) = 700$ lb-sec

$K_3 = 3500$ lb-sec/sec

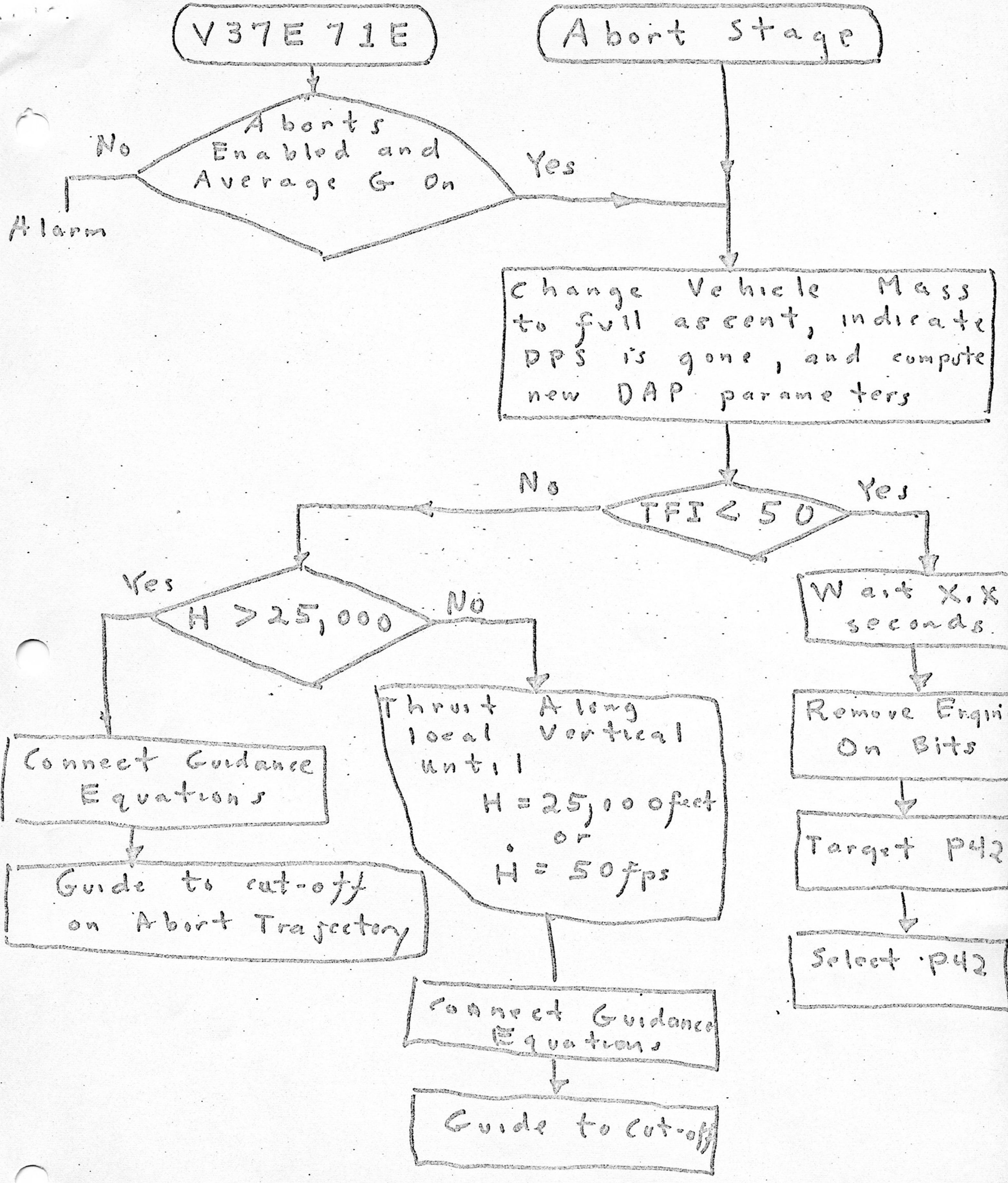


Fig. 2 Flow Graph for New P71